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Does the American Tariff Protect Labor?

William P. Travis

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Massachusetts Institute of Technology

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Several recent articles have suggested substituting the formulary

$$b_j = \frac{t_j - \sum_{i=1}^n a_{ij} t_i}{1 - \sum_{i=1}^n a_{ij}}$$

for the ordinary rate of duty, reported in the tariff schedule, in evaluating the protectiveness of the tariff.¹

In this formula, t_j is the rate of duty on imports of the j th product and a_{ij} is the amount of the i th product required for the production of one unit of the j th product. This (physical) input coefficient is supposed to be that which would prevail under universal free trade. Lacking that information, one must assume the input coefficients to be invariant with respect to relative prices.

Basevi and Belassa have provided the first application of

this formula to the measurement of b_j , the "effective rate of protection." They find that the average of such rates exceeds the average of duties reported for the United States and for several other countries, studied by Belassa. They find also that there is no apparent relationship between the effective rate of protection and any general explanatory variable, such as labor intensity, for example.²

This last finding, they assert, contradicts the contrary conclusion of B. N. Vaccara that highly protected industries in the United States tend to be those which use many laborers per dollar's worth of final output.³ It also contradicts the findings of Professor Lorie Tarshis that show that products which are expensive in the United States compared to Japan, the United Kingdom, and the Soviet Union, are those which show a high ratio of labor to capital, while industries with low ratios of labor to capital produce their products cheaply compared to their counterparts in the other countries. The comparison with Japan was the most striking, while the Soviet Union and the United Kingdom

were intermediate cases, as one would expect from an a priori idea of their relative supplies of labor and capital.⁴

Tarshis's results, which Basevi and Belassa ignore, were so clearly cut and so in line with the predictions of the Heckscher-Ohlin theory that Tarshis was astonished that the influences of product differentiation, economies of scale, classification error, differences in production function, etc., etc., failed to show up more than they did.⁵

This was all the more astonishing since Tarshis, like Vaccara, used direct, rather than direct-plus-indirect input coefficients. The latter determine final prices, in conjunction with the wages of primary factors, and are the appropriate measure to use for correlations with either the duties or with relative prices. The high correlation between the two types of coefficients, however, makes the use of the direct coefficients perfectly appropriate, considering the difficulty of obtaining the direct-plus-indirect coefficients for nearly so many sectors as Vaccara and Tarshis were able to examine with their other data.⁶

Transport costs and all other impediments to trade in addition to tariffs work in the same direction, of course, to widen

price disparities and they thus strengthened the relationships Tarshis found. In addition, taking the ratio of the inputs of labor, which is expensive in the United States, to those of capital, which is cheap, eliminated the influence of third factors. Third factors can account for low inputs of both labor and capital in some cases, and so erode the correlation between labor coefficients alone and tariffs or prices. But neither of these advantages in Tarshis's method is an unfair one for testing the Heckscher-Ohlin theory, since that is, after all, primarily a theory of the determination of relative prices on the basis of the relative prices of primary inputs. Tarshis has found that relative prices of primary inputs are important and his results are of great significance to the theory of international trade. It is somewhat perplexing that they have been systematically overlooked by trade theorists.

I argued, from Tarshis's and Vacarra's findings and from my own studies of tariff structures and policies, that Leontief's paradoxical findings could be explained by protection. Leontief

found that the United States exports, net, the services of a tiny amount of labor and imports, net, those of a small, but more substantial, amount of capital. When products which, like most manufactures, depend directly upon no third factor, like land or natural resources, are alone considered, Leontief found, however, that the United States exports a small amount of capital, net, in return for a small amount of labor, net.⁷

These findings can be explained, rigorously, as follows. Suppose first that the United States traded freely and that the Heckscher-Ohlin theory holds. Leontief's test then would have found a substantial export of capital, and land, services in return for those of labor. This is because of the enormous endowment of both capital and land which the United States enjoys, when compared to the rest of the world. Suppose now, that the United States raises a tariff against imports, and that other countries do the same thing. Since manufactures happen, on the average, to be quite labor intensive, American production of manufacturers would increase under protection, and only the

most capital-intensive ones would continue to be exported. Leontief's test at each stage of increasing protection would register a smaller and smaller net exchange of capital services for those of labor. Under very high tariffs here and abroad the exchange would become zero.

The difficulty arises in explaining how the normal type of exchange can actually reverse itself. Much effort has been spent trying to find general, that is, theoretical reasons to explain it: reasons like the switching-over of factor intensities under different relative prices of primary factors. Unfortunately, the explanation of Leontief's paradox is not general, but very particular. It is merely a quirk of nature. Most of our competitive imports consisted, at the time Leontief made his study, of crude oil, paper pulp, primary copper and lead, and metallic ores. These products are more capital intensive than any manufacture based on them, and than any manufactured product at all. They were imported because we lacked sufficient natural resources, of those specific types, to meet the home demand for them. No matter how small our exports of manufactures, therefore, their

average capital-labor ratio could not have exceeded that of the competitive raw material imported.

Under free trade, or freer trade, those particular imports would have been much less important. Imports of labor-intensive manufactures would have diminished their relative and absolute importance in total imports. But it was precisely those imports which the tariff kept out, for all imports of manufactures were only about one percent of national income. The severe constriction of trade in manufactures is alone sufficient, then, to explain the Leontief paradox.⁸ That constriction comes from both sides, of course, and cannot be measured by looking only at the American tariff. Also, import and export subsidies, under various guises, must be examined to explain fully the little trade in manufactures that does persist under protection. Import subsidies are often disguised in the form of low tariffs and high exchange rates, export subsidies in the form of various discriminatory allowances or production subsidies. These rarely make any

allowance for comparative advantage, but instead are adjusted to bring in foreign exchange almost regardless of costs in terms of the domestic currency.⁹

Basevi directly challenges the conclusion that protection explains the Leontief paradox because he found no correlation between the measure b_j , defined above, and the direct labor coefficients. Moverover, when he refined that measure to include only the value which labor added, he found a distinct negative correlation between protection and labor intensity. The refined measure is equal to

$$e_j = \frac{t_j - \sum_{i=1}^n a_{ij}t_i - k_j r}{1 - \sum_{i=1}^n a_{ij} - k_j r}$$

for the j th sector. In this formulary, k_j is the number of dollar's worth of capital the j th sector uses per dollar's worth of the j th commodity, and r is the world's rate of interest.¹⁰

Basevi finds that the "labor rates of protection," e_j , calculated from this formula are "...from about four to five times as high as the nominal (tariff) rates."¹¹ He thus seems to conclude that the American tariff does protect labor, which, after all, is the only primary factor in his model.¹²

The so called "new theory"¹³ of protection leaves us, then, with a perplexity: labor may well be protected by the American tariff, but not labor-intensive industries. Somehow the tariff raises the price of labor without giving preferential treatment to those sectors which use much labor. And this occurs even though, by Basevi's own calculation, the correlation between tariff rates and direct labor-input coefficients was about .71.¹⁴

2. The theoretical issues

Basevi called the finding that the total rates of protection (the b_j 's) were about one and a half times as high as nominal rates and the finding that the labor rates were four or five times the nominal rates the most important results of his study.¹⁵ Belassa, too, is concerned with finding in some appropriate average rate the measure of a country's protectiveness, despite

Viner's injunction against any such attempt.¹⁶ As Belassa points out, the interest in such a measure has been stimulated by the Common Market and the GATT negotiations, particularly the Kennedy Round. In such negotiations, each country generally tries to show that its own tariffs are harmless, its partners' tariffs are high, and that it should therefore receive rather than give concessions. These exercises thus give rise to a process of mutual recrimination, and that process seeks its own theory of protection and its measurement. The "new tariff theory", by showing that effective rates may well exceed nominal ones, is of obvious importance to negotiators.

According to Belassa, the restrictive effect of a country's tariff, under general equilibrium, can be indicated by the difference between its actual imports and those which would take place if the county in question eliminated all of its duties.¹⁷

The existence of more than one partner country, and their imposition of tariffs, complicate the problem and invalidate this statement. Suppose that only three countries exist, the United

States, Japan, and the EEC, and suppose that the United States and Japan together have exactly the same relative endowments of land, labor, and capital as the EEC and as all three countries taken together. Suppose, however, that the United States has a disproportionately large share of the total supply of capital and land and a disproportionately small share of the total supply of labor. Suppose further that all the normal assumptions of the Heckscher-Ohlin theory hold: identical productive knowledge in all countries, identical qualities of the three factors in each country, productive functions homogeneous of the first degree, etc., and suppose that there are many, many commodities.

If the United States and Japan both trade freely with one another, then either all factors will receive the same wages in either country and thus equalize the costs of production, or else the equalization of the prices of commodities will force the closure of labor-intensive industries in the United States and of capital-intensive industries in Japan.

Protection in this case would serve two functions: it would cause factor prices to diverge as between the two countries, and it would also support industries that would disappear without it because of that disparity in factor costs. If each industry receives the minimum protection necessary to preserve it under a given set of domestic and foreign factor prices, then tariffs will be related to input requirements.

This can be shown easily from the formulas which relate the prices of commodities to those of factors under general equilibrium. Let p_0 be the vector of factor prices and p the vector of commodity prices. Let $(I - A)$ be the Leontief matrix and let F be the matrix of primary input coefficients. Then

$$p' = p_0' F (I - A)^{-1} = p_0' G,$$

where G is the matrix of direct-plus-indirect input coefficients and where the primes indicate transposition. The elements g_{kj} of the matrix G , like the elements a_{ij} of the Leontief matrix, are functions of all relative

prices. The system of equations is really an identity only, which must hold everywhere. It shows the association, however, between high factors prices and high commodity prices. Tariffs on the trade between the two countries maintain those differences in commodity prices.

Under free trade between Japan and the United States, relative prices in both countries would be the same as those in Europe, provided, of course, either that European tastes were like those prevailing in the Japanese-American common market, or that Europe too traded freely. But as Japan and America apply protection, Europe is faced with cheaper prices of both labor-intensive and capital-intensive products. Europe would gain, at the willing but unwitting expense of the protectionist countries, by letting in these artificial imports, but if she did not do so, her relative position would be exactly the same as that under universal free trade. If her industrialists are concerned that all industries exist, they will opt for protection too, and for the structure of production prevailing under Japanese-American free trade.

Clearly Europe's tariff has a much different meaning from that of either Japan or the United States in this example, since in the strict sense it is not protectionist. Thus tariff rates cannot be evaluated without considering the tendencies for anomalous trade set up by the tariffs of third countries.

Averages of duty rates would be particularly misleading in the example, unless appropriate corrections were made. The average level of duties in Europe could be higher than that in the United States, for example, even though the European tariff is purely compensatory. The United States will have high duties on labor-intensive products, but zero duties on capital-intensive products. Europe, meanwhile, will have moderate tariffs on both categories. Moreover, the United States and Japan could take over themselves the function of the European tariff by levying moderate duties on commodities which are moderately intensive in labor or capital and which Europe would export in return for products at either extreme. Then Europe's average tariff would be zero and both Japan's and the United States's higher than before; and yet nothing real-neither relative prices

in any country, nor the operation of any industry--would be any different.

Because trade is a circuit, which country applies tariffs or other restrictions, or whether imports or exports are taxed, makes no essential difference so far as relative prices are concerned. The collection of the customs duties will be affected however, and there will be a marginal affect on trade according to the differences in the expenditure patterns of the various countries which collect customs revenue. Thus, through a system of import and export duties, the United States could simulate perfectly all the present joint Japanese-American restrictions on their mutual trade even though the Japanese levied no duties of their own. In this case, the United States would simply be collecting duties on both sides. The former Japanese duties would be added to American national income, however, and Americans would probably spend that revenue somewhat differently from Japanese. Trade and domestic production, and finally, in some small degree, customs revenues as well would be affected by this difference in tastes; but that would be the only difference, and it would be a very small one beside the primary effects of

the protection.

This means, of course, that the average level of a country's duties means nothing. Only two things are important in assessing the primary seriousness of protection: differences in relative prices as between countries, and their shares in the collection of customs duties supporting the disparity in relative prices.

For some purposes, such as Vaccara's, for example, it may not be too serious to neglect foreign duties. American import duties should be correlated with labor intensity, foreign import duties with capital intensity; and one can look at one side or the other. But this is inadequate when the "effective rates" are examined. A domestic sector may benefit from a foreign tariff on its raw materials, in relative abundance at home, and yet the sector's product may compete with imports. In this event, calculating effective rates only from the country's own tariff underestimates the degree of protection. Since the United States has a comparative advantage in a wide range of capital-intensive intermediate products, the effective rates calculated by Basevi and Belassa have been systematically distorted.

There is a still more fundamental misconception involved in the use of "effective rates", however. Corden claims that they indicate the way in which resources will be pulled by the tariff:

"...one must ask what the purpose of the effective-protective-rate-concept is. The answer is that it should shed light on the direction of the resources-allocation effects of a protective structure. If we have calculated that tradable industry X has 10 percent effective protection and tradable industry Y has 20 percent, we should be able to conclude that resources will be drawn from X to Y and into both from non-protected tradable industries and from those non-traded industries where prices have stayed constant."17

"...the calculation of effective rates is designed to indicate the direction in which resources will be pulled by the tariff structure. It should not incorporate the effects of those resource shifts....we want to know what the rise in the rate of return to a factor is before any resources move in response to this rise. Hence, the effective rate would be the percentage rise in the return to the primary factor which would result if there were no substitution between inputs and, hence, if there were no change in the input coefficient. It follows that the ideal calculation should use the input coefficient of the free-trade situation..."18

The tariff is observed at a certain point of time. If the rates have been in effect for some time, presumably the system has

adjusted to them in the sense that the rate of profit is the same in every industry and every industry pays the competitive wage for each of the various allocable resources and factors it employs. No calculation made from the tariff will tell us how resources will move because they have moved already, and they have stopped moving until the next alteration in the tariff or in some other parameter of the system. Corden's "model" is not a dynamic model; he is not even talking about changes in the tariff, in which case the domestic coefficients as observed would be perfectly valid. He apparently imagines that the system just keeps on changing forever, in the way indicated by his "effective protective rates," with respect to some primordial free trade "situation."

The only relevant practical problem, that of a change in one or more tariffs affecting a given industry, can be dealt with directly without calculating the "effective protective rate." Suppose a country is contemplating lowering the duty on a product, how can it tell how that sector will fare? The level of the duty is irrelevant; all that matters is the decline in the domestic price of the article as a result of the concession. Suppose that

the concession will lower the landed cost of competing articles by 5 percent.¹⁹ If the domestic industry earns profits on its sales equal to only 3 percent, it will clearly be in trouble. For this calculation, one needs not look at tariffs on inputs at all, unless they are going to be changed. In that event, the savings to the industry can be added to its profits as a percentage of final sales to the domestic market to see if the industry can absorb the decrease in the tariff on its own product; at no stage is the level of any tariff, or the level of the "effective protective rate" calculated from those levels, necessary or appropriate. Finally, even though profits may not disappear altogether, they may become abnormally low as a percentage of capital invested in the industry. In this event, the industry will not disappear overnight necessarily, but will close down as its committed fixed capital wears out.²⁰ In any event, it is ordinary financial data, and not the "effective protective rate", which indicate how resources will be allocated.

The only serious theoretical issue raised by the new tariff concept is that stemming from the failure of the "effective rates

of protection" to correlate with labor coefficients according to the predictions of the Heckscher-Ohlin theory. As Belassa says, the trouble may be with the Heckscher-Ohlin theory itself:

"It is suggested here that the explanation lies in the inadequacy of Heckscher-Ohlin-type theories that rely on a single classifying principle--factor proportions--in attempting to explain international specialization and consider protection in its effect on the income of the scarce factor. In appraising the structure of protection in the industrial countries, we can hardly neglect technological factors, however."²¹

The classical theory explained all trade by differences in the input coefficients of the primary factors. Ricardo, in his famous example, did not consider third commodities that might be intermediates in the production of wine and cloth. Had he done so, however, nothing essential would have been changed. England's inefficiency in wine and cloth production could be explained partly by its wasteful use of their intermediates.²² All of this could have been suppressed, however, by calculating for each country its direct-plus-indirect labor input coefficients and comparing those in determining comparative advantage. Thus

the formula

$$p = G'p_0$$

still applies. In the full classical model, the matrix G will have but a single row, corresponding to the single factor labor, and the vector of factor prices, p_0 , will have but a single element, representing the wage of labor. This formula will still be correct even though the intermediates are traded between England and Portugal, so long as tariffs are adjusted in such a way as to maintain some production of each intermediate in each country.

If the duty on a particular intermediate is too low, however, and that product is entirely imported, it becomes, from the point of view of the importing country, a primary factor, and its price, inclusive of whatever duty it may still be subject to, must be put in the vector p_0 . In addition, a row must be created for it in the matrix F , and its row and column must be deleted from the matrix $(I - A)$. At this point, of course, the simple monofactor world has become somewhat more complicated, and some sort of Heckscher-Ohlin considerations will apply to at

least one country.

Because it is a matter of common observation that more than one primary factor exist and that commodities differ, under any given relative factor prices, in their direct and indirect use of those factors, presumably Belassa and the others want to assume that the classical effect of differing production functions supervenes in determining relative prices, but does not rule out entirely the effects of factor proportions. Belassa is really claiming, therefore, that variations in factor proportions are insignificant, or that relative factor prices differ slightly among countries, or that differences in productive efficiency systematically run counter to the effects of differing factor proportions. For if differences in productive efficiency were merely random, the systematic differences in factor costs among industries should still show through^{as} in Vaccara's and Tarshis's studies. But Belassa's and Basevi's work eliminates this influence almost entirely. Very special assumptions are necessary to explain that result even if the Heckscher-Ohlin effects are only secondary.

The explanation, it will not be surprising to learn, lies in the method that Basevi and Belassa used and in their application of that method, and not in the theory.

Explanation of Basevi's results

Basevi and Belassa made several fundamental errors in their work. One of the simplest is their correlation of the measure b_j , which relates protection to value added per unit, with the amount of labor used per dollar's worth of output, rather than with the amount used per dollar of added value. The value added per dollar's worth of output varies from industry to industry in a way that is perfectly random so far as labor intensity is concerned, and it was this, in effect, which they correlated with a very imperfect surrogate of the tariff. No wonder, then, that they failed to reproduce Vaccara's theoretically justifiable correlation.²³ If Basevi and company want to use a measure that expresses the tariff in units of value added, they should relate it to a measure of labor also in units of value added.

But even that modification would not justify the use of the measure b_j , as a bit of reflection on the various measures derived from the tariff and on the nature of correlation itself will show. For handy reference, the arguments will be made in terms of a simple numerical example, based on a simple general equilibrium model. This model assumes that all input coefficients whether of primary or of intermediate inputs, are invariant with respect to relative prices and the same in all countries. Two countries are examined, which like Japan and the United States in our earlier example, are taken to be the ones with the most divergent factor prices. Countries with neutral endowments are ignored because they normally should not trade with the countries under examination.

The fixed labor and capital coefficients are given in columns A1 and A3 of the Table. Wages are taken to be \$7 in country A and the returns on each "machine", or unit of capital, to be \$1. The corresponding prices are \$1 and \$5 in country B. The Leontief matrix, in physical terms, is taken to be

$$(I - A) = \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \text{in both countries.}$$

Thus the first sector produces an intermediate commodity used by the second sector. All sectors except the second are completely integrated vertically. Column A6 is derived from the familiar relation $p^A = (I - A') F' p_0^A$, and column A7 is derived in the same way, using country B's factor prices.

Column A4 gives the amounts of labor used per dollar's worth of final product in country A. These are the coefficients correlated with the tariff by Vaccara, and with the measure b_j by Basevi. The Column A5 gives the amount of labor used directly and indirectly per dollar's worth of output. It is the coefficient which Vaccara should have correlated with tariffs.

The equilibrium tariffs implied by the prices in columns A6 and A7 are reported in column C1. The concept, h_j^{AB} , used there thus differs from the nominal tariff duty, t_j , which may be too high, in a particular case, to allow imports, or too low to support domestic productions of the j th product. The super-

scripts indicate that the tariff applies to the trade between country A and country B. It thus accounts for both countries' tariffs, as is strictly necessary. It would be impossible to talk sensibly, for example, if country B levied a tariff on the third product and a zero duty were reported for country A. The order of the superscripts indicates, however, that all equilibrium duties are computed as if country A levies the taxes. Thus

$$h_{j}^{AB} = \frac{p_j^A - p_j^B}{p_j^B}$$

whereas

$$h_{j}^{BA} = \frac{p_j^B - p_j^A}{p_j^A}$$

If one computed the arithmetic average of the $h_{j,s}^{BA}$, derived from the same prices as those assumed, it would differ from that computed for column C1. This shows, again, the trivial nonmeaning of the average duty, for nothing else in the example would be altered.

Measures of Protection

A. Coefficients and Prices

	(1) direct labor per ton	(2) direct+ indirect labor per ton	(3) direct capital per ton	(4) direct labor per dollar in A at A's prices	(5) direct+ indirect labor per dollar in A at A's prices	(6) prices in country A	(7) prices in country B
	<u>l_j</u>	<u>l^*_j</u>	<u>k_j</u>	<u>l^{oA}_j</u>	<u>l^{*oA}_j</u>	<u>p^A_j</u>	<u>p^B_j</u>
Sector:							
1	3	3	1	$\frac{3}{22}$	$\frac{3}{22}$	22	8
2	1	4	3	$\frac{1}{32}$	$\frac{1}{8}$	32	24
3	1	1	3	$\frac{1}{10}$	$\frac{1}{10}$	10	16
4	4	4	4	$\frac{1}{8}$	$\frac{1}{8}$	32	24

Measures of Protection, (continued)

B. Concepts of value added

(1) value added, at A's factor prices, per ton in A	(2) value added, at B's factor prices, per ton in B	(3) value added per dollar at A's prices in A	(4) value added per dollar at B's prices in B	(5) value added per dollar in A at B's prices	(6) direct labor per dollar of value added in A at A's prices	(7) value added by labor in A per dollar's worth of value added, at B's prices
v_j^A	v_j^B	v_j^{oA}	v_j^{oB}	v_j^A	$\frac{l_j^A}{\frac{A}{v_j}}$	$\frac{l_j}{\frac{B}{v_j}}$

Sector:

1	22	8	1	1	$\frac{11}{4}$	$\frac{3}{22}$	$\frac{3}{8}$
2	10	16	$\frac{5}{16}$	$\frac{2}{3}$	$\frac{5}{12}$	$\frac{1}{10}$	$\frac{1}{16}$
3	10	16	1	1	$\frac{5}{8}$	$\frac{1}{10}$	$\frac{1}{16}$
4	32	24	1	1	$\frac{4}{3}$	$\frac{1}{8}$	$\frac{1}{6}$

Measures of Protection

C. Measures of protection derived from the equilibrium tariff and preceding sections of this table

1) for country A:

1 product concept (equilibrium tariff)	2 sector concept #1	3 sectoral protect- ion per dollar added, at domestic prices	4 sector concept #2	5 Basevi's measure
h^{AB}_j	δ^{AB}_j	β^{AB}_j	d^{AB}_j	b^{AB}_j
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>

Sector:

1	$\frac{42}{24}$	$\frac{336}{192}$	$\frac{210}{120}$	$\frac{42}{24}$	$\frac{42}{24}$
2	$\frac{3}{24}$	$\frac{-167}{192}$	$\frac{-334}{120}$	$\frac{-6}{24}$	$\frac{-9}{24}$
3	$\frac{-9}{24}$	$\frac{-72}{192}$	$\frac{-45}{120}$	$\frac{-9}{24}$	$\frac{-9}{24}$
4	$\frac{8}{24}$	$\frac{64}{192}$	$\frac{40}{120}$	$\frac{8}{24}$	$\frac{8}{24}$

Arithmetic
averages: $\frac{49}{24}$

Column C5 gives Basevi's measure, which has, however, been corrected in the same way as the tariff measure. Basevi's measure can be computed by several routes. If value added per unit of output is known directly for both countries, it can be computed best directly as

$$b_j^A = \frac{v_j^A - v_j^B}{v_j^B} .$$

These values added per physical unit of output are reported in columns B1 and B2. Column B₆ shows the amount of labor used per dollar's worth of value added in country A (column A₁ divided by column B₁), and column B₇ shows the amount of labour used by each sector per dollar's worth of value added by that sector in country B (column A₁ divided by column B₂).

We can now see that the tariff is nicely correlated with the direct-plus-indirect labor coefficients (column A₅) in the high wage country, country A. Both sectors, for example, which directly and indirectly use the same amount of labor per dollar's worth of the final product have the same tariff. Their domestic

costs of production diverge from their foreign costs by exactly the same amount.

It is hard to see why this correlation, therefore, would be wrong, as Basevi and company assert. It is true that the second sector happens to use an intermediate product which may be imported, and which pays a tariff if it is imported. If that tariff was raised, the cost of producing the second product would not rise, nonetheless, but rather imports would cease and the domestic suppliers would continue to offer it, under either their own cutthroat competition or under threat of vertical integration on the part of the producers of the second product, at the same price. That price, their cost of production, is determined by the wage rate, \$7, and the capital cost, \$1, in country A, and the cessation of imports of the first product would not alter those wage rates. That is because country A produces three commodities with only two factors, and the exact outputs are indeterminate.²⁴ A rise in the nominal tariff would thus leave the equilibrium tariff unchanged. It would, of course,

be wrong to use the nominal rather than the equilibrium duty in the correlation, but that objection applies much more seriously to the calculation of the measures b_j from the nominal tariff, as we shall see.

Basevi's measure gives the same result for the second and third sectors, which have the same structures of direct costs. It is a bit ironic to notice that it washes out entirely the fact that the second sector, but not the third, uses an intermediate input; thus Basevi's measure does not, after all, take those inputs into account. Every sector with the same structure of value added will show the same "effective" degree of protection, regardless of whether or not it uses intermediates. But the actual protection it requires will depend upon intermediates, as the equilibrium duty reveals.

And this is why Basevi's measure fails to show any correlation with the direct labor coefficients of column A_4 . Both the second and the third sector use the same number of workers per unit of final output, but the value of one unit of the final output of the second sector, which must buy an intermediate product, is considerably higher than that of one unit of the

final output of the third sector. Basevi's measure does correlate, however, with column B_7 or, for that matter, with column B_6 , as we should expect. A careless mistake is thus the foundation of the empirical side of the new tariff theory.

In the above examples, all the advantages have been given to Basevi's measure. It has been calculated on the basis of actual values added per unit in either country, information which must be estimated darkly and laboriously in real life. The exercise illustrates one important point, however. Basevi's measure and the equilibrium tariff measure exactly the same thing, for one is just an unnecessarily complicated transformation of the other. When the transformation is made, however, it is necessary to make the same transformation on the variable being correlated with protection.

This suggests other, more natural, transformations. If one is interested in direct labor coefficients and in the role of intermediates, he might wish to use the measure:

$$\delta^{AB} = (I - A^O A') h^{AB}$$

In this formulary, $(I - A^O{}^A)$ is the matrix of input coefficients in units of country A's prices. It is equal to

$$\text{diag } p^A (I - A) \text{diag } p^{A-1} ,$$

where $\text{diag } p$ is the diagonal matrix of prices. Column C_2 of the Table reports this measure, which can be seen to correlate with the direct labor coefficients, per dollar's worth of final output, reported in column A_4 and corresponding to the coefficients used by Vaccara. Notice also that the second sector, which is penalized by having to rely on an input which the domestic tariff raises in price, shows a lower degree of protection than the third sector which, nonetheless, has the same structure of direct costs. This measure δ_j , then, seems to be what the new school of tariff theorists are seeking, but it is clearly equivalent to using the nominal tariff rates in conjunction with the direct-plus-indirect input coefficients.

For many reasons, the use of tariffs and direct-plus-indirect coefficients is better, although, even under ideal circumstance, that correlation cannot be perfect. Tariffs should be more highly correlated with the ratios of labor to capital, or of labor to

land, or of labor to any other universal factor which is unprotected by the tariff, than to the labor input alone. This is because third factors, including noncompetitive imports, can account for a large part of the value of various commodities. Furthermore, the tariff will not be colinear with any measure derived from inputs, that is, the correlation coefficient will not be unity even though the relations $p = G' p_0$ completely determine prices in every country and every country has the same input coefficients. In the present example, for example, in which only Heckscher-Ohlin considerations determine relative prices, the R^2 between the tariff, h^{AB} and the direct-plus-indirect labor inputs for each dollar's worth of output is only .39, even though we see that the tariff is exactly the same whenever the labor coefficient is the same. This is, of course, the limitation of any correlation coefficient: it can indicate the existence of a relationship, but not the structure of that relationship. For that, we need the complete theory.

The correlation coefficients between various transformed versions of tariffs and labor coefficients will not be the same, in general, as those between the tariff and the direct-plus-indirect coefficients. The correlation coefficient is the cosine of the angle formed in the sample space by the two vectors being correlated. The vectors h^{AB} and l^{*O^A} in the present example form an angle in the space of commodities whose cosine is the square root of .39. The vector δ_j is a linear transformation of the vector h^{AB} and the vector l^{O^A} is the same transformation of the vector l^{*O^A} ; but the R^2 between δ_j and l^{O^A} is not equal to .39. They would be the same only if h^{AB} and l^{*O^A} were actually colinear.

This draws attention to the danger of interpreting the underlying theoretical relationship through the veil of too many, and therefore too exiguous, transformations. We could, for example, go one step further and compute

$$\beta' = \delta' \text{ diag } v^{O^A-1}$$

a measure akin to Basevi's, but computable from domestic data even if the assumption of fixed input coefficients is abandoned. In this measure, v_j^{OA} is the value added per dollar's worth of final output, at A's prices, in country A. It is reported in column B_3 of the Table. The measure β_j is reported in column C_3 , which is derived by dividing column C_2 by column B_3 . This measure should be related to $\frac{l_j}{v_j}$, reported in column B_6 , derived by dividing column A_4 by column B_3 . The correlation coefficient for columns B_6 and C_3 has not been computed, but there is no reason to suppose that it is the same as that between tariffs and direct-plus-indirect labor. It will be observed, however, that the new measure fails to be the same for the second and the third sectors even though labor has the same share in the value added of each.

Basevi's measure escapes this anomaly because, in the present example where everything is known, it can be computed directly from the values added per physical unit in either country.

The string of assumptions and supererogatory calculations that have to be made in practice make it unmanageable.

Basevi's measure can be computed in the two equivalent forms:

$$b^{AB}_j = \frac{d^{AB}_j}{v^O_B_j} = \frac{v^A_j - v^B_j}{v^B_j} .$$

The measure d^{AB}_j is related to the measure δ^{AB}_j , but it is derived from the other country's input output matrix, in terms of its prices:

$$d^{AB'} = t^{AB'} (I - A^{OB'}) .$$

Notice that the vector t^{AB} , rather than h^{AB} , has been used because the nonequilibrium duties, t_j , were the ones that Basevi used for his calculations. The measure reported in column C_4 is based on the equilibrium tariffs, however, to facilitate its comparison

with δ_j . It can be seen that it reverses the relative protection of the second and third sectors, and is thus inferior to δ_j , which can be calculated directly from the domestic input coefficients.

The measure d_j requires more tenuous calculations, for the matrix, $(I - A^{OB}) = \text{diag } (1 + t)^{-1} (I - A^{OA}) \text{diag } (1 + t)$ and its estimation will be disturbed by any nonequilibrium duties in the vector t (the superscripts have been dropped for simplicity). The measure d_j , as a reflection of equilibrium duties, suffers twice from wrong duties. But, since

$$v^A = 1' (I - A^{OA}) \text{diag } (1 + t) \quad \text{and}$$

$$v^{OB} = 1' \text{diag } (1 + t)^{-1} (I - A^{OA}) \text{diag } (1 + t),$$

the inexactness of t flocculates the estimate b_j of protection yet once again.

The impression of utter randomness in Basevi's results is complete only when one considers how uncertain was the estimate

even of the matrix $(I - A^{OA})$, which is the foundation of all the other uncertain estimates. For most sectors, his data distinguished no more than 40 inputs. From one third to two thirds of the cost of material inputs was lumped under the heading "other material inputs," to which Basevi assigned arbitrary duties which affected his final estimates.²⁵ Untraded inputs were treated as though their tariffs were zero, whereas, of course, their domestic prices diverged from their foreign prices just as if they had been traded and dutied.

These serious inaccuracies are, for the most part, inherent in the concept of the "effective protective rate". It requires so many complicated transformations, so much data, and so many assumptions--about input coefficients under free trade, elasticity of supply, etc.--which are untrue, that it is bound to obscure rather than reveal the relationship between d_j and domestic labor per dollar's worth of value added in the other country. All this is unnecessary, however, because the correlation between the nominal duty and direct-plus-indirect

labor coefficients requires only one matrix transformation, which legitimately can use the domestic input-output table without correction for foreign prices or assumptions about its value under universal free trade.

Basevi tried to measure the wrong things, but his empirical work was detailed and laborious and potentially capable of finding the existing, legitimate, correlations, as his recalculation of Mrs. Vaccara's correlation shows. Belassa's empirical work, on the other hand, would be incapable of obtaining the correlations that exist. He used only 36 sectors made to fit the tariffs and labor coefficients of several countries. His intermediate coefficients were all taken from two countries, whereas, with the proper measure, it is a country's own coefficients which should be used. Moreover, Belgium's and Holland's low duties do not mean that their coefficients are those which would prevail everywhere under universal free trade because their partners do not trade freely with them. The degree of aggregation in Belassa's work, the problems of statistical concordance it raises, and the use of rank correlation all wipe out the extremes in duties and coefficients which are the crux of the whole matter. Finally, some of the countries in the sample have neutral comparative advantage vis à vis the United States on the one hand, and Japan and other low wage countries on the other, and their tariffs would not be expected to reflect strongly the influence of capital intensity or labor intensity.

It remains to examine the disturbing negative correlation between the "labor rate of protection" and direct labor per dollar's worth of output and the proposition that the labor rate of protection is nonetheless very high.

The high labor rate of protection poses no problem, for, under the assumptions of the numerical example above, Basevi's measure is simply a surrogate for the disparity in American and foreign wages. It is equal to the percentage by which the value which labor adds per unit of output in the United States exceeds the value foreign labor adds per unit of output:

$$e_j = \frac{l_j^A w^A}{l_j^B w^B} - 1 .$$

If the coefficients vary with the international difference in wages, then Basevi's estimate is a minimal estimate of that difference, for the foreign labor input coefficient will then be larger than the domestic coefficient, and foreign wages must be correspondingly

smaller. In either case, the measure should be the same from sector to sector, because wages will be the same for all industries in either country. The measure e_j will then be a constant, uncorrelated with anything at all.

Basevi's measure was negatively correlated with labor intensity for the simple reason that, as he estimated it, it was a clumsy measure of capital intensity. He assumed that the cost of capital was the same in the United States as abroad on the grounds that capital, like intermediate goods, moves from country to country. ²⁶

Thus, lacking direct information on value added by labor abroad, he subtracted capital's share from the added values he calculated for each American sector. This was equivalent to calculating:

$$e_j = \frac{l_j^A w_j^A}{l_j^B w_j^B + k_j^B r_j^B - k_j^A r_j^B} - 1.$$

If the primary coefficients, but not the interest rates, are assumed

to be equal in both countries, the measure he actually computed is equivalent to

$$e_j = \frac{l_j w^A}{l_j w^A - k_j (r^B - r^A)} .$$

If r^B exceeds r^A , in accordance with the facts, then the estimate of e_j will be higher the higher is the relative share of capital.²⁷

It is one of the injustices of scholarship that those who do the most work are the most subject to criticism and attack. Basevi's fundamental errors are not his alone, but those of the literature on implicit tariffs. Basevi has been singled out for the main attack only because he presented concrete, refutable evidence and hypotheses. The subject is, after all, very difficult; its difficulty and importance make a vehement attack necessary.

And, although Basevi's measure is incorrect, he did perform

a valuable service in computing the correlation coefficient between Vaccara's measure of tariff protection and the direct labor coefficient, per dollar's worth of output, which coefficient Vaccara herself did not actually compute. The R^2 for 1954 was low, but that for 1958, when the data were better and by which time tariff negotiations had brought more duties into line with their equilibrium levels, was clearly significant: .507. The primary correlation, of course, is between the tariff, or rather the equilibrium duties, and the direct-plus-indirect coefficients. It would therefore have been embarrassing if Basevi had found too much correlation.

The correlation between the two types of coefficients is inherent since

$$\begin{aligned} 1^*{}^0 &= 1^0 I + 1^0 A^0 + 1^0 (A^0)^2 + \dots + 1^0 (A^0)^n \\ &= 1^0 (I - A^0)^{-1} \end{aligned}$$

and all the elements a^0_{ij} are less than unity. Thus the direct coefficients tend to dominate in the determination of the direct-plus-indirect coefficients. The actual correlation coefficient cited

earlier, is .886. This does not indicate directly what the correlation between tariffs and direct-plus-indirect coefficients is, but the range within which that correlation coefficient must fall can be computed.

Suppose, for notational simplicity, that there are three vectors, a, b, and c, and that the correlation, r^{ac} , between a and c is known and that r^{bc} is also known. The maximum and minimum correlation, r^{ab} , between a and b will occur when all three vectors lie in the same two-dimensional plane in the n-space of observations. The coefficient r^{ac} is the cosine of the angle A between a and c, r^{bc} is the cosine of the angle B between b and c. Consequently,

$$\cos (A+B) \leq r^{ab} \leq \cos (A-B) \quad .$$

The tariff vector and the vector of direct labor coefficients, according to Basevi's R^2 of .507, form an angle of $44^\circ 45'$, the cosine of which is .71. The vector of direct labor coefficients and that of direct-plus-indirect labor coefficients form an

angle of $27^{\circ} 38'$, the cosine of which is .886. The maximum possible angle between tariffs and direct-plus-indirect labor coefficients is therefore $72^{\circ} 13'$, and the minimum possible angle is $17^{\circ} 7'$. The minimum possible correlation coefficient for tariffs and direct-plus-indirect labor coefficients is therefore .30542, and the maximum is .95571. The theory tells us, however, that the primary correlation is between tariffs and direct-and-indirect coefficients; their correlation coefficient must therefore be greater than that between the tariffs and the direct labor coefficients. It seems reasonable to conclude, therefore, that tariffs (or rather Vaccara's rather imperfect surrogates for them) are correlated with direct-plus-indirect labor coefficients with a coefficient lying somewhere between .71 and .96. The American tariff does indeed protect labor and labor intensive products.

Footnotes

1. The formula first appeared in my Harvard Ph. D. thesis where it was discussed at length. See W. P. Travis, "On the Theory of Commercial Policy," (1962), pp. 214-250. I dropped this approach at the time primarily because I had determined empirically that the assumption of fixed input coefficients is untenable (see W. P. Travis, The Theory of Trade and Protection, Cambridge 1964, chs. 5 and 6); because under variable coefficients the formula becomes essentially meaningless; and because the existence of intermediates does not affect the determination of final prices anyway under general equilibrium and the assumptions made. This point will be explained more at length in this article, but c. f. The Theory of Trade and Protection, pp. 126-143. It means, as we shall see, that the equilibrium rates of duty tell us all we need to know about the the structure of protection, provided only, as the concept of equilibrium duties implies, that

they are adjusted to international cost differences.

The literature that has unfortunately sprung up around the misapplied concept of the so-called "effective degree of protection", embodied in the above formula, seems to stem from Clarence L. Barber, "Canadian Tariff Policy," Canadian Journal of Economics and Political Science, vol. XXL, No. 4. (November 1955), pp. 513-530. Barber does not actually present the formula in that article, but points out that a given sector suffers or gains, under a given tariff, according to whether or not its raw materials enter with high duties or not. He suggests that the percentage by which all the tariffs augment or decrease value added be used as the measure of protection. The suggestion has been taken up and elaborated in the following articles:

Corden, W. M., "The Tariff," in Alex Hunter, (ed.), The Economics of Australian Industry, Melbourne, 1963;

Johnson, H. G., "The Theory of Tariff Structure with Special Reference to World Trade and Development," Trade and Development, Geneva: Institute Universitaire des Hautes Etudes Internationales, 1965;

Belassa, Bela, "Tariff Protection in Industrial Countries: An Evaluation," Journal of Political Economy, LXXIII, (December 1965) pp. 573-594;

Basevi, Giorgio, "The U. S. Tariff Structure: Estimate of Effective Rates of Protection of U. S. Industries and Industrial Labor," Revue of Economics and Statistics, Vol. XLVIII, No. 2 (May 1966) pp. 147-160;

Corden, W. M., "The Structure of a Tariff System and the Effective Protective Rate," Journal of Political Economy, Vol. LXXIV, No. 3, (June 1966) pp. 221-237; and

McKinnon, Ronald I., "Intermediate Products and Differential Tariffs: A Generalization of Lerner's Symmetry Theorem," The Quarterly Journal of Economics, Vol. LXXX, No. 4 (November 1966), pp. 584-615

2. Basevi, op. cit. pp. 157-159 and Belassa, op. cit., p. 585.
3. Beatrice N. Vaccara, Employment and Output in Protected Manufacturing Industries, The Brookings Institution, Washington, D. C., 1960.
4. Lorie Tarshis, "Factor Inputs and International Price Comparisons," in Moses Abramovitz and others (eds.) The Allocation of Economic Resources, (Stanford, 1959) pp. 236-244. Tarshis's results have been analyzed extensively in W. P. Travis, The Theory of Trade and Protection, op. cit., pp. 91-94, 107n, 111-112, 193, and 199.

5. Tarshis, op. cit., pp. 241-242.
6. The correlation coefficient between direct and direct-plus-in-direct labor coefficients, as reported by Leontief for 1947, is .886. See Travis, op. cit., p. 193.
7. Leontief, W. M. "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis," Review of Economics and Statistics, 38: 4: 386-407 (November 1956).
8. But the complementarity between capital and certain specific resources cannot explain it under free trade. See Travis, op. cit., Chapters 3 and 4 for more detailed theoretical and empirical discussion. For the labor and capital input coefficients, see ibid., Appendix II.
9. Obfuscation and obnubilation are mandatory under the GATT's rules and under the Anti-dumping regulations of every importing country. In many cases, even the exporter cannot tell what price he can profitably quote. Countries with severely over-valued exchange rates tie imports of raw materials and machinery to exports or impose export quotas. Neither system inherently favors exports of commodities intensive in the country's abundant productive factors.

10. Basevi, op. cit., pp. 150-151. Basevi uses a different but equivalent form of the equation, for his computations. The above form is more convenient for analysis.
11. Basevi, op. cit., p. 157.
12. Basevi both affirms and denies that value added per unit by workers or by workers and capital gives an indication of factor returns. One would normally think, for example, that value added per unit of output by labor is equal simply to the wage rate times the number of workers employed by the sector per unit of the final commodity it produces. But Basevi, in footnote 5, page 148, of his article says that the analysis is carried on at a level that permits no inference regarding the effect of protection on factor prices. This statement seems to mirror a similar one made by Johnson (H. G. Johnson, op. cit., pp. 10-11). In the last paragraph in the following footnote, Basevi says that the purpose of the measure of protection is either to compare factor returns under protection with those in the foreign country or with those which would hold under free trade.

13. The term is both Corden's and Basevi's.
14. Basevi ran a straight regression between Vaccara's measure of the tariff for each sector and labor coefficients. His R^2 was equal to .507 for the year 1958. See Basevi, op. cit., p. 158.
15. Basevi, p. 157
16. Belassa, op. cit., p. 573
17. Corden (1966), p. 227
18. Corden (1966), p. 234
19. This implies, of course, that the tariff is at least 5% ad valorem, how much it exceeds 5% is of no concern here.
20. If the industry has an important captive factor, as do mining industries, for example, profits per dollar of sales may well rise as output diminishes. In those cases, the industry will not necessarily disappear altogether in response to too low a duty. See . . . Travis, op. cit., pp. 148-149 for a full discussion of determinate and indeterminate degrees of protection.
21. Belassa, op. cit., p. 585.
22. Note that the "New Tariff" school assumes only the direct primarily coefficient to vary from country to country.

23. Their cavalier dismissal of which is very upsetting. It is as though someone said that a radio were faulty for picking up a station his could not receive. Vaccara's results must be explained; that will be done in this section.
24. There are only three commodities in the relevant sense because the rank of the matrix F is only three, for the first and the second sectors have the same capital-labor ratios. If imports of the first product are kept out by too high a tariff, the effective number of commodities is only two, however. This is because the matrix G in this example is equal to

$$G = \begin{bmatrix} 1 & 4 & 3 & 4 \\ 3 & 4 & 1 & 4 \end{bmatrix} \quad . \quad .$$

If the first product stops being traded, it is as if the second had been produced all along in both countries under an integrated production function. Then G , or F since the example no longer has any intermediate sector, is equal to

$$F = \begin{bmatrix} 4 & 3 & 4 \\ 4 & 1 & 4 \end{bmatrix}$$

the rank of which is only two. More will be said about the treatment of untradables in a forthcoming paper.

25. Basevi, p. 152.
26. There is no reason to suppose that mobility of capital equalizes its returns, however. Capital-labor ratios would then be the same in every country and it would be impossible to explain high American real wage rates. It is a rare observer, moreover, who feels that capital is so cheap or so readily available abroad as it is in the United States. If India, for example, can get capital as cheaply as it is available in the United States and as much as it wants, then what is her development problem?
27. Unfortunately, if the sector is too capital intensive, the measure becomes infinite. If it is yet more capital intensive, it becomes negative. In this sense, the measure is only a crude estimate of capital intensity. A better one would be the one that Tarshis, for example, used: the simple ratio of capital to labor.

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